Patent Claims

1. Method of joining a bolt or fastener element (10), having a head portion (12), a shaft portion (16) and at least one radial groove in its shaft portion, to a sheet metal component (52) by forming a hole in said sheet metal component in such a way that a collar (120) of material is formed at the side of the sheet metal component remote from the head portion of said fastener element, with the material of said collar (120) being is subsequently deformed radially inwardly into said radial groove (28) by a die button, characterised in that a die button is used having a ring-shaped projection provided at its end face surrounding a tapered recess (112) and having sloping flanks (222,226) for pressing said sheet metal component upwardly into a recess (20) provided under said head portion (12) of said fastener element (10) and radially inwardly towards said shaft portion (16) into said radial groove (28) in the transition from said head portion (12) to said shaft portion (16).

2. Method in accordance with claim 1, wherein a base portion (113) of said tapered recess (112) serves to define the axially outermost end of said collar (120) when deformed into engagement with said element.

3. Method in accordance with claim 2, characterised by the steps of
- guiding the fastener element by means of a setting head through the sheet metal component (52) or through another plate-like component consisting of deformable material, with an end (100) of said

shaft portion remote from the head portion (12) being at the front, and with the sheet metal component (52) being pierced by the end (100) of the shaft portion (16) under the action of the setting head (38) thus forming a hole in the sheet metal component (52) on penetration thereof by said end (100) with the formation of said collar (120) and the ejection of a slug (116), and
- broadening the hole formed in the sheet metal part (52) by the pushing through of the thread (14) formed at the shaft part (16) of the bolt element, with the simultaneous dilation of the collar (120) which is located around the hole on the die side.

4. Method in accordance with claim 3, wherein said collar (120) which is formed during the piercing of said sheet metal component and which surrounds said hole at the die side is dilated as said shaft portion is pushed through said hole.

5. Method in accordance with claim 3 or claim 4, characterised in that the end (100) of the shaft portion (16) remote from the head portion (12) is used not only to push out the slug (116) from the sheet metal component (52), but rather also to generate at least one and preferably a plurality, and in particular a non-even number of notches, or at least substantially radially directed cuts or tears in the rim of the hole.

6. Method in accordance with any one of the claims 3, 4 or 5, characterised in that the piercing of said sheet metal component is effected using a bolt element (10) which has a spigot-like projection (101) at its end (100) remote from the head portion (12), with said projection

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having a diameter which is somewhat smaller than the core diameter of the thread.

7. Method in accordance with claim 6, wherein a conically divergent portion of said spigot-like projection (101) adjacent said thread is used for initial dilation of said hole.

8. Method in accordance with claim 7, wherein shape features (106) provided at said spigot-like projection (101) are used to exert a cutting action at the rim of said hole.

9. Method in accordance with any one of the preceding claims, wherein the step of deforming the material of said collar radially inwardly into said radial groove comprises deforming the material of said collar radially inwardly into one or more thread turns (28) on the shaft portion of the element, said one or more thread turns forming said radial groove.

10. A fastener element (10) which can be inserted by riveting into a sheet metal component (52), in particular a bolt element (10), the element (10) consisting of a shaft portion (16) and a head portion (12) formed in one piece therewith, in particular for carrying out the method in accordance with one of the claims 1 to 9, wherein the rivet connection to the sheet metal component takes place in the region of the head portion (12)and wherein the shaft portion (16), which is preferably equipped with a thread, is formed at its end remote from the head portion (12) to punch through the sheet metal component, characterised in that the end (100) of the shaft portion (16) remote from the

head portion (12) has a spigot-like projection (101), having an outer diameter which is smaller than the core diameter of the shaft portion, said shaft portion preferably being provided with a thread, and in that the spigot-like projection (101) has at least one, and preferably a plurality of cutting features (106), in particular a non-even number of cutting features which, on punching through the sheet metal component, slightly notch or tear the rim of the hole at the corresponding positions.

11. Bolt element in accordance with claim 10, characterised in that the spigot-like projection (101) merges via a truncated cone section (102) into the thread, the truncated cone section preferably having a cone angle of approximately 90°.

12. Bolt element in accordance with claim 11, characterised in that the cutting features (106) are formed by grooves which extend in the longitudinal direction of the projection (101) and which are in particular of V-shape in cross-section and the depth of which reduces in the axial direction of the shaft portion in the direction towards the thread and preferably goes to zero in front of the thread, with the one side wall (108) of each V-shaped groove preferably lying in a radial plane.

13. Bolt element in accordance with claim 11, characterised in that the cutting features are formed by ribs on the spigot-like projection in the longitudinal direction thereof, with the ribs preferably lying within a circle coaxial to the thread, said circle having a diameter smaller than the core diameter of the thread.

14. Bolt element in accordance with any one of the claims 10 to 13, characterised in that the spigot-like projection has a so-called Ka-shape in accordance with DIN 78 or an Asp-shape in accordance with DIN 78 (German Industrial Standard 78).

15. Bolt element in accordance with one of the preceding claims 10 to 14, characterised in that the end face (104) of the shaft portion remote from the head portion (12) is a surface which is at least substantially perpendicular to the mean longitudinal axis of the bolt element and which can optionally be slightly concave or convex.

16. Bolt element in accordance with one of the preceding claims 10 to 15, characterised in that the first thread turns of the thread (14) are made substantially harder than the following turns of the thread.

17. Bolt element in accordance with one of the preceding claims 10 to 16, characterised in that the head portion (12) of the bolt element is formed in accordance with the German patent application P 44 10 475.8, and in particular in that the element (10) has peripherally closed fields at its concave lower side serving as a contact surface (18), with the concave fields being at least partly bounded by ribs (22) extending outwardly away from the shaft portion (16), and with the shaft side ends (24) of the ribs (22) extending in raised form along the shaft portion (16) and merging at the ends (26) remote from the head portion (12) into at least one recess (28) extending spirally around the shaft portion.

18. Bolt element in accordance with claim 17, characterised in that the

shaft portion (16) of the element has a larger diameter in the region of the raised ribs (28) in comparison to the shaft portion (16) remote from the head portion (12), with the at least one recess (28) being located in this region of greater diameter.

19. Bolt element in accordance with claim 17 or claim 18, characterised in that the peripherally closed fields (20) have their greatest depth adjacent to the shaft portion (16).

20. Bolt element in accordance with one of the preceding claims 17 to 19, characterised in that the proportion of the area of the fields in comparison to the contact surface (18) of the head portion are so selected that they result in an ideal security against rotation and non-critical surface pressure taking account of the material pairing.

21. Bolt element in accordance with one of the preceding claims 17 to 20, characterised in that the closed fields (20) are bounded at their radially outer boundary by a peripheral surface (30) of the head portion (12).

22. Bolt element in accordance with one of the preceding claims 17 to 20, characterised in that the rib parts (22) which are located in the contact region of the head portion (12) and preferably extend in the radial direction become broader radially outwardly and merge without interruption into a peripheral surface (20) of the contact region (18) of the head portion (12).

23. Bolt element in accordance with one of the preceding claims 17 to 22,

characterised in that the number of ribs (22) preferably lies between 6 and 8.

24. Bolt element in accordance with one of the preceding claims 17 to 23, characterised in that the closed fields (22) are at least substantially square in plan view.

25. Bolt element in accordance with one of the preceding claims 17 to 24, characterised in that the base surfaces of the closed fields (20) lie at least substantially on a conical surface having an included angle (Â) of preferably 130° to 140°.

26. Bolt element in accordance with one of the preceding claims 17 to 25, characterised in that the side of the head portion (12) remote from the contact surface (18) has a centring recess (34) extending coaxial to the longitudinal axis of the element.

27. Bolt element in accordance with one of the claims 17 to 26, characterised in that the element (10) has a thread (14), with the at least one spiral recess (28) being formed by a thread groove.

28. Bolt element in accordance with one of the preceding claims 8 to 27, characterised in that it is a functional part, for example a bearing spigot.

29. Riveting die, in particular for use with a bolt element in accordance with one of the preceding claims 8 to 28, characterised in that, for the generation of a plastic deformation of the sheet metal material, it

has either a peripherally extending wave-like end face having hills (72) and valleys (74) in the axial direction, or has a roof-like ring wall at the end surface, with the end surface having a central ring recess with a diameter larger than the outer diameter of the thread and which merges via a ring shoulder into a smaller diameter which is fractionally larger than the outer diameter of the thread .

30. Riveting die in accordance with claim 29, wherein said central ring recess has a wall 115 which tapers in diameter in the direction of the insertion of said bolt element.

31. Riveting die in accordance with claim 29 or 30, characterised in that said ring recess has a ring-step at its end remote from the roof-like ring wall.

32. Component assembly comprising a sheet metal component (52) and a bolt or nut element (10), the element (10) consisting of a shaft portion (16) and a head portion (12) formed in one piece therewith, wherein the element (10) has peripherally closed fields at its concave lower side serving as a contact surface (18), with the concave fields being at least partly bounded by ribs (22) extending outwardly away from the shaft portion (16) and with the shaft side ends (24) of the ribs (22) extending in raised form along the shaft portion (16) and merging at the ends (26) remote from the head portion (12) into at least one radial groove (28) extending around the shaft portion, wherein the sheet metal comprises a ring collar (113) at the side remote from said head portion, said ring collar being deformed radially inwardly into said radial groove (28) and wherein the metal of the sheet metal com-

ponent (52) is at least partly plastically deformed into the concave fields (20) and into engagement with said ribs (22) extending outwardly away from the shaft portion (16), and with the shaft side ends (24) of the ribs (22) extending in raised form along the shaft portion (16).

33. Component assembly in accordance with claim 32, characterised in that the radially outer contour of said collar and its projection beyond the adjacent face of said sheet metal component are selected so that they lie, at least at the end remote from said sheet metal component, within or at most just contacting a recess within a nut element threaded onto said shaft portion and used to secure a second sheet metal component to the first said sheet metal component, said second sheet metal component having an aperture therein which fits with clearance around said collar.

34. Component assembly in accordance with claim 32, characterised in that the sheet metal component (52) has a groove (80) which extends at the side opposite to the contact surface (18) of the head portion (12) substantially coaxial to the longitudinal axis of the element and which is optionally interrupted.

35. Component assembly in accordance with claim 34, characterised in that the groove (80) has a wave-like base surface (81).

36. Component assembly in accordance with the claims 34 to 35, characterised in that regions which are raised above the plane of the sheet metal component (52) are provided between the groove sections

of an interrupted groove (80) for electrical contact purposes.

37. Component assembly in accordance with any one of claims 32 to 36, wherein said collar (120) has a conically tapering outer surface which tapers in the direction away from said head portion (12).

38. Component assembly in accordance with one of the claims 32 to 37, wherein said radial groove extending around said shaft portion comprises one or more thread turns.

39. A method of attaching a fastener element to a plastically deformable metal panel, said fastener element including a shank portion and an integral head portion extending radially from one end of said shank portion, and said shank portion including a radial groove generally adjacent said head portion, said method comprising the following steps:

- forming an opening in said panel having a diameter generally equal to or greater than said fastener element shank portion, but less than said head portion,

- deforming said panel surrounding said panel opening into a generally cone-shaped portion projecting from said panel having a minor diameter at said panel opening,

- disposing said fastener element shank portion through said panel opening from a side of said panel opposite said projecting cone-shaped portion,

- then deforming said panel cone-shaped portion into a generally tube-shaped portion closely conforming said fastener element shank portion, thereby supporting said shank portion, and

- using a die button having a tapered recess engaging an outer side of tube-shaped portion to deform said tube-shaped portion radially inwardly into said shank portion radial groove, thereby preventing withdrawal of said fastener from said panel opening.

40. The method of attaching a fastener element to a panel in accordance with claim 39, wherein said fastener element shank portion includes a generally cylindrical free end portion having a generally smooth external surface, said method including driving said fastener element free end portion against said panel, thereby generally simultaneously deforming said panel to form said cone-shaped portion and piercing a slug from said panel, forming said panel opening.

41. The method of attaching a fastener element to a panel in accordance with claim 40, wherein said fastener element cylindrical free end portion has a diameter less than said shank portion and said shank portion including a generally conical portion extending inwardly from said shank portion to said cylindrical free end portion, said method including driving said cylindrical free end portion of said shank portion through said panel as defined in claim 39, then driving said conical portion of said fastener element shank portion through said panel opening, thereby enlarging said panel opening and substantially simultaneously drawing said conical panel portion into said tu-

bular-shaped panel portion, then deforming said tubular panel portion radially inwardly into said shank portion radial groove.

42. The method of attaching a fastener element to a panel in accordance with claim 41, wherein said cylindrical free end portion of said shank portion includes generally longitudinally extending spaced grooves having relatively sharp edges adjacent the cylindrical surface of said cylindrical end portion, said method including driving said cylindrical end portion against said panel, tearing and piercing said panel, and forming said generally conical panel portion having a torn discontinuous edge surrounding said panel opening, then deforming said discontinuous edge radially inwardly into said radial groove in said shank portion.

43. The method of attaching a fastener element to a panel in accordance with claim 41, wherein said shank portion is externally threaded and said radial groove comprises at least one male thread generally adjacent said head portion, said method including deforming said panel tubular portion radially inwardly into the groove defined by said one male thread.

44. The method of attaching a fastener element to a panel in accordance with claim 41, wherein said radial groove in said shank portion is spaced from said head portion, said method including deforming the end of said panel tubular portion radially inwardly into said radial groove in said shank portion.

45. The method of attaching a fastener element to a panel in accordance

with claim 39, wherein said fastener element head portion includes a groove generally adjacent said shank portion, said method including deforming said conical panel portion spaced from said panel opening into said groove in said head portion substantially simultaneously with deforming said panel portion radially inwardly into said radial groove in said fastener element shank portion.

46. The method of attaching a fastener element to a panel in accordance with claim 39, wherein said shank portion of said fastener element includes a first radial groove immediately adjacent said head portion and said shank portion is externally threaded including a first plurality of male threads adjacent said first radial groove having a diameter greater than the remaining threads on said shank portion, said method including deforming said generally tube-shaped panel portion radially inwardly into said first radial groove and the radial grooves defined by said first plurality of male threads.

47. The method of attaching a fastener element to a panel in accordance with claim 46, wherein said method includes hardening said first plurality of male threads adjacent said radial groove prior to attachment of said fastener element to said panel.

48. A male fastener element for attachment to a plastically deformable metal panel, said male fastener element including a generally cylindrical shank portion having a free end and an enlarged integral, radially extending head portion at one end of said shank portion, said shank portion externally threaded to adjacent said free end portion with said free end portion having a relatively smooth cylindrical sur-

face including a plurality of generally longitudinally extending cutting grooves having relatively sharp cutting edges adjacent said smooth cylindrical surface.

49. The male fastener element in accordance with claim 48, wherein said smooth cylindrical free end portion of said male fastener element has a diameter less than the diameter of said externally threaded portion and said shank portion includes a relatively smooth conical portion extending from said threaded portion to said relatively smooth cylindrical surface of said fee end portion.

50. The male fastener element in accordance with claim 48, wherein said shank portion is threaded to adjacent said head portion, including a first plurality of male threads adjacent said head portion having a diameter greater than the remaining threads on said shank portion and wherein said first plurality of threads is hardened relative to said remaining threads.

51. The male fastener element in accordance with claim 48, wherein said head portion includes a groove surrounding said shank portion extending angularly inwardly to said shank portion.

52. The male fastener element in accordance with claim 51, wherein said shank portion includes a relatively smooth radial groove adjacent said head portion.